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Study the role of entrance channel angular momentum on the fusion-fission and quasifission reactions

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In heavy-ion induced reactions, the interaction mechanism is primarily governed by the projectile beam energy and angular momentum (L) of the composite system. The collision of two heavy nuclei can generate a significantly large reaction angular momentum. This is because heavy-ion projectile beams ($Z > 4$) can transfer more L to the nucleus in a given reaction compared to light-ion beams. Therefore, a fissioning nucleus can be produced through different projectile-target nuclei combinations, but the reaction channel that has been carried out using the heaviest projectile beam will be produced at comparatively higher angular momentum. In addition to excitation energy, the value of L in a heavy-ion reaction also influences the valley of the potential energy surface (PES) of the fissioning nucleus [1-4]. Therefore, an attempt has been made to produce a fissioning nucleus through different entrance channels at similar excitation energies in order to investigate the role of entrance channel angular momentum on different reaction mechanisms.
The experiments were performed at the Flerov Laboratory of Nuclear Reactions (FLNR), JINR, Russia, using energetic beams of ^{16}O and ^{48}Ca delivered from the $U400$ cyclotron. The thin targets of ^{208}Pb and ^{176}Yb were bombarded with the ^{16}O and ^{48}Ca beams, respectively at different beam energies to produce the same fissioning nucleus, ^{224}Th around the barrier from $E_{CM}/V_B \approx 0.96 - 1.28$. The measurements of the reaction binary products were carried out by utilizing the double-arm time-of-flight (TOF) spectrometer CORSET [5]. Assuming the conservation of mass of the composite system of projectile and target, the double-velocity method was employed to determine the mass and energy of the reaction products.
The Mass-Total Kinetic Energy (M-TKE) distributions of the primary binary fragments from ^{224}Th has been obtained from the two different reactions. However, the former reaction, ^{208}Pb(^{16}O, f) is expected to follow a purely CN fusion-fission process based on the charge product (Z_1Z_2) of the reactions that is about 656 and 1400, respectively. Therefore, the Coulombic repulsion barrier is stronger in case of the heavy-ion reaction, ^{176}Yb(^{48}Ca, f). The latter reaction is subject to significant influence of quasifission reaction mechanism in addition to fusion-fission process. Detailed multimodal analysis has been carried out on the experimental mass and energy distributions of the binary fissionlike fragments.

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